Regulating Earth Stations in Motion (ESIMs) for NGSO Systems

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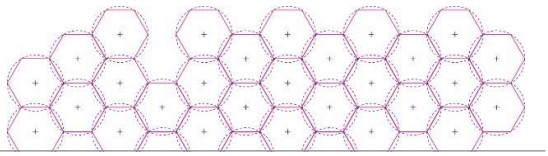
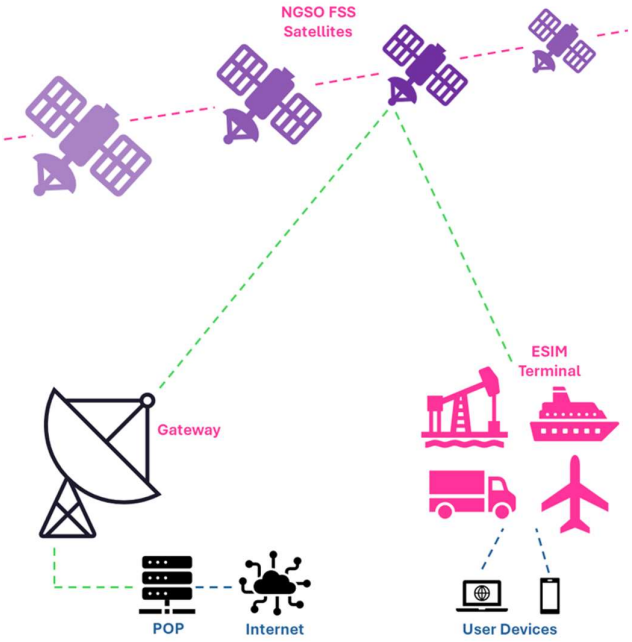


As satellite communication rapidly advances, Earth Stations in Motion (ESIMs) emerge as pivotal elements in modern connectivity, particularly as the industry witnesses the rise of large constellations of non-geostationary (NGSO) fixed-satellite service (FSS) systems. These emerging constellations, poised to provide global broadband coverage, intensify the need for a more supportive regulatory framework for NGSO FSS ESIMs. ESIMs, which include stations on aircraft, ships, and land vehicles, facilitate high-bandwidth, reliable connections to moving targets. This technology's evolution brings forth complex regulatory challenges, necessitating a harmonized approach across international telecommunications and satellite communication domains. With the increasing demand for continuous mobile connectivity and the shift towards higher frequency bands, regulatory bodies face the critical task of balancing efficient spectrum utilization with the protection of existing services. This paper delves into the regulatory frameworks shaping NGSO FSS ESIM operations.



Context

ESIMs are satellite communication systems designed for mobility. They are capable of establishing and maintaining communication links with satellites while in motion. ESIMs are increasingly used for broadband Internet access, broadcasting services, and emergency communication services, adaptable to both Non-Geostationary Satellite Orbit (NGSO) and Geostationary Satellite Orbit (GSO) systems.

They typically consist of a stabilized antenna system that automatically tracks and communicates with satellites. For NGSO systems, this involves dynamic tracking due to the relative movement of satellites in orbits like Low Earth Orbit (LEO) or Medium Earth Orbit (MEO). For GSO systems, ESIMs align with a fixed point in the equatorial orbit where satellites appear stationary relative to the Earth's surface.

ESIMs have become increasingly critical in delivering mobile connectivity across diverse environments. They operate within fixed-satellite service (FSS) frequencies and are essential for connecting user terminals moving on land, at sea, and in the air. As ESIM technology has evolved, it has become increasingly important to establish a global regulatory approach for their authorization, especially in countries where they operate or pass through.

The emergence of large NGSO FSS constellations, especially in the Ka-band, brings new regulatory challenges. Many countries currently lack domestic processes to authorize mobility services for NGSO FSS constellations in these frequencies, highlighting a need for extensive preparatory activities and advocacy. Additionally, the introduction of ESIMs has amplified existing spectrum challenges. The International Telecommunications Union (ITU) World Radiocommunication Conference 2023 (WRC-23) has considered some of these emerging challenges. This demonstrates the global community's effort to establish a harmonized and forward-thinking regulatory framework. This framework is not just necessary but imperative to adapt to the rapid advancements in satellite communications and ensure seamless global connectivity.

International Framework

The international regulatory landscape for ESIM is primarily shaped by the ITU Radio Regulations (ITU-RR), which set the ground rules for spectrum use internationally and determine operational obligations for co-frequency services. While ITU-RR provides a well-established framework for GSO FSS ESIM,

including operational standards and interference management guidelines, it currently lacks a specific regulatory framework for NGSO FSS ESIM, particularly in the Ka-band. The ITU's efforts are geared towards developing a regulatory framework for NGSO FSS ESIM that facilitates global mobility licensing, especially crucial in countries that have yet to establish their own regulations. This includes stipulating maritime coordination distances and power flux-density (PFD) restrictions for aeronautical ESIM to ensure harmonious operation and minimal interference with terrestrial services.

However, the implementation of any WRC-23 resolution at the national level may take additional years. This underscores the need for a tailored regulatory strategy for each country, especially considering that land-based ESIM, which face unique regulatory hurdles, are not currently under consideration at WRC-23.

National Frameworks

Nationally, there is a significant variance in the development of NGSO ESIM frameworks, particularly outside the United States and Europe. In the United States, a comprehensive framework includes blanket licensing for all types of ESIM that communicate with NGSO FSS systems in Ku- and Ka-band frequencies. An approach characterized by its inclusivity, allowing various ESIM operations under a unified regulatory umbrella, which simplifies the process for operators and encourages technological innovation and deployment.

Other countries, like those in the European Union, have established generally favourable regulatory environments for ESIM operations. Some nations have developed frameworks that support a broad range of ESIM activities while ensuring that these systems coexist harmoniously with other satellite and terrestrial communications services (e.g., Portugal, Ireland, Italy). On the other hand, countries like Canada and Australia have crafted more specific regulations, tailoring their ESIM policies to address local needs and existing communication infrastructures. These regulations might include restrictions on the types of ESIMs approved or limitations on the frequency bands they can operate in.

There are also countries that require individual terminal licensing for ESIM operations, adding an additional layer of regulatory oversight (e.g., Argentina). This approach is often found in regions where there is a need to closely monitor and manage the spectrum due to existing heavy usage or potential interference concerns.

However, it's important to note that a substantial number of countries still lack specific frameworks for NGSO ESIMs. This absence of regulation can pose challenges for the deployment and operation of ESIMs, particularly in emerging markets or in countries where satellite communication technologies are still developing.

This global disparity in ESIM regulation underlines the importance of understanding each country's unique approach to regulating this evolving technology. It also highlights the role of regional frameworks and country leaders in shaping the future regulatory landscape for ESIMs, ensuring a cohesive and efficient approach to satellite communication globally.

Regional Frameworks

Regionally, Europe stands as a frontrunner in the development of NGSO FSS ESIM licensing frameworks in the Ka-band, primarily led by the European Conference of Postal and Telecommunications Administrations (CEPT) and its European Communications Committee (ECC). The ECC's non-binding Decision (15)04, which aims to set standards for NGSO FSS ESIM operation under a blanket licensing regime, illustrates Europe's proactive approach. However, its implementation has been uneven across its member states, reflecting the challenges in achieving uniformity in regulatory practices.

In the Americas, the Inter-American Telecommunication Commission (CITEL) has been actively working on blanket licensing regimes for both GSO and NGSO ESIMs in the Ka- and Ku-bands. Meanwhile, the African Telecommunications Union (ATU) is advocating for national frameworks that facilitate seamless ESIM operation, highlighting the rising significance of satellite communications in Africa.

The situation calls for active engagement with national regulators and regional groups to advocate for domestic national regulatory frameworks approving all types of ESIM communicating with NGSO FSS systems. This includes advocating for blanket licensing regimes and regulations supporting the free circulation of ESIM. The lack of harmonized frameworks poses challenges, but it does not make approvals impossible. NGSO operators will need to strategically and carefully select appropriate countries and regions for their mobility operations, taking into account the specific regulatory landscapes and advancements in each area.

Challenges and Opportunities

Despite the regulatory and technical challenges, land, maritime, and aeronautical ESIMs each offer significant opportunities for enhancing global connectivity, fostering industry collaborations, and driving technological innovations. These opportunities can lead to improved services in remote areas, safer and more efficient transportation, and a better overall user experience.

Land ESIM

Land ESIMs are particularly challenging in terms of potential interference with terrestrial telecommunications, a concern that has not been fully addressed by the ITU. Without specific technical and regulatory provisions from the ITU for the operation of land-based NGSO ESIMs, these systems face an uphill battle for global standardization and acceptance. Regionally, bodies like CITEL have been hesitant to advocate for the free circulation of foreign-registered land ESIMs, often treating them as domestic issues. Furthermore, certain countries either lack specific regulatory frameworks for land ESIM or exclude them from blanket licensing in specific frequency bands, which makes the deployment and operation of these systems more complex and location-dependent.

However, the regulatory challenges faced by land ESIMs also open up opportunities for innovation and policy development.

There is significant potential for these systems to enhance connectivity in remote and underserved areas where terrestrial networks are sparse or non-existent. Additionally, as the demand for global internet coverage increases, there's an opportunity for collaboration between industry stakeholders and regulatory bodies to establish a more harmonized global framework. This could lead to the development of new standards and technologies that better address interference issues and make land ESIMs more viable and efficient.

Maritime ESIM

Maritime ESIMs, which usually operate in international waters and primary Fixed-Satellite Service (FSS) bands, have a different set of regulatory and operational considerations. They require dual licensing: both from the country in whose waters they operate and the country that flags the ship. Additionally, maritime ESIMs face specific requirements when transmitting within 70 kilometres of a nation's shore. The deployment of these systems is often facilitated by agreements with systems integrators who already hold the necessary operational licenses, easing the process of establishing maritime ESIMs on vessels.

For maritime ESIMs, the opportunity lies in vastly improving communication capabilities for vessels at sea. This enhancement is not just in terms of basic connectivity but also in enabling high-bandwidth applications like real-time navigation, autonomous vessels[1], weather monitoring, and efficient maritime logistics. The dual licensing system can foster international cooperation and potentially lead to streamlined processes, making it easier for ships to maintain continuous communication links. Additionally, stronger partnerships with systems integrators can expand market reach and enhance service offerings, potentially opening new revenue streams and business models in the maritime sector.

Aeronautical ESIM

Aeronautical ESIMs, used on aircraft, must address compatibility with aircraft avionics, a factor scrutinized by the ECC which established maximum Equivalent Isotropically Radiated Power (EIRP) levels for this purpose. The ITU imposes Power Flux-Density (PFD) restrictions on GSO operations, especially when an ESIM is within sight of a nation's territory. These restrictions are particularly stringent below 3 kilometres altitude, effectively precluding "gate-to-gate" operations. Moreover, aeronautical ESIMs must navigate the highly regulated nature of aviation: they require airworthiness certification either for the terminal itself or for the entire aircraft, a process that can delay deployment.

This has led to a preference for installing ESIM terminals during aircraft manufacture rather than retrofitting existing aircraft. The regulatory landscape also distinguishes between ESIMs used for payload applications, like providing passenger data, and those for control or safety applications, with the latter facing more stringent restrictions and potential prohibitions in future regulations.

Aeronautical ESIMs present a unique opportunity to revolutionize air travel communications. By providing high-speed internet connectivity and a range of communication services to aircraft, they can significantly enhance the passenger experience. The push for incorporating ESIM technology during aircraft manufacturing (line fit) presents an opportunity for collaboration between aviation and telecommunication industries, potentially leading to innovations in aircraft design and onboard communication systems. The distinction in regulations between payload and control applications also opens the door for specialized services, with payload applications offering avenues for in-flight entertainment and connectivity services, while control applications could see advancements in aircraft operation and safety systems.

Conclusion

ESIMs hold vast potential. The integration of ESIMs with NGSO systems, while presenting unique challenges, also opens doors to unprecedented opportunities. To realise this potential will necessitate a deep understanding of technological capabilities and challenges, an appreciation for varied policy and regulatory options, and recognition of both global and regional approaches.

About Orbital Reach

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Orbital Reach and Plum

Francois Lambert is an Associate at Plum.

Together, Orbital Reach, with its specialist focus on the space sector, and Plum Consulting, with its established expertise in spectrum management, policy, and regulation, are ideally placed to assist in navigating this evolving landscape. We can offer expert insights and guidance in shaping policies that align with the latest technological advancements and operational needs.

[1] Plum Consulting, February 2023, *Autonomous vessels – can the potential benefits be realised?*, https://plumconsulting.co.uk/plum-insight-autonomous-vessels-can-the-potential-benefits-be-realised/